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AUTHOR Oakley, Wayne F.; Crocker, Robert K.
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ABSTRACT

Investigated were teacher-pupil and pupil-pupil relationships in the context of elementary science activities, of which the characteristic feature was the predominance of small group work by pupils without continuous teacher direction. Two pairs of pupils from each of ten classes were recorded for a single class session using two independently operated portable videotape recorders while they participated in science activities. Transcripts of the tapes were coded using a classroom analysis scheme designed to reflect the process nature of the activities, to emphasize the notion of teacher control, to code physical actions, and to permit identification of individual pupils as both senders and receivers of communication. Among the results of the analysis of the tapes were that: (1) teacher and pupils initiated approximately equal numbers of interventions; (2) long interventions, regardless of initiation, almost invariably ended with the teacher giving directions on procedures; and (3) the proportion of teacher talk was almost universally greater than for the two pupils combined. (MH)

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AN EXPLORATORY STUDY OF TEACHER INTERVENTIONS IN ELEMENTARY SCIENCE LABORATORY GROUPS

Wayne F. Oakley
Newfoundland Department of Education
St. John's, Newfoundland, Canada

Robert K. Crocker
Institute for Educational Research and Development
Memorial University of Newfoundland
St. John's, Newfoundland, Canada

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Newfoundland Department of Education

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Background and Rationale

The study reported here forms one aspect of a larger study of teacher-pupil and pupil-pupil relationships in the context of elementary science activities. The classes under investigation were characterized by direct pupil investigation of science problems, including pupil data gathering and interpreting. In these classes, pupils typically worked in pairs, each pair having its own set of apparatus. Teacher-class interactions generally took place at the beginning of a lesson, when a problem was introduced, and at the end, when pupil findings were summarized and an attempt made to achieve closure on the problem at hand. During the remainder of each class session, the salient group for the study of interactions was the pupil pair. During this time, the teacher was usually circulating about the classroom, engaging in discussion with one group at a time. It is this latter type of interaction, referred to as teacher interventions, which forms the basis for the present study.

The study as a whole was designed to focus on the question of teacher control of pupil activity in the setting described. The rationale for the study of control derives from Barker's behaviour setting construct (Barker, 1968) and from Bernstein's concept of strong and weak framing (Bernstein, 1971) as a classification of the range of options open to the teacher

and pupils in the classroom. More specifically, the behaviour setting theory leads to the concept that an individual's behaviour in a particular setting may be influenced by his perceptions of the goals of the setting and his role in the setting. It might be argued from this that different degrees of teacher control may lead to different pupil role perceptions. With regard to the concept of framing, the focus in this study was on the question of the degree to which the teacher expands or restricts the range of pupil options, particularly in terms of lesson pacing, apparatus arrangements, data collection, specific results to be sought, and so on.

In the larger study, the issue of control was first investigated descriptively, using data obtained from the video-taping of thirteen class sessions operating in the general manner described above. In a second phase, an experimental study was conducted in which specific teacher behaviours related to the control concept were induced (Note 1). The data on which this paper is based were obtained from the first phase videotapes.

The specific rationale for the study of teacher interventions stems from a possible contrast between teacher-pupil relationships in the class and group settings. The nature of the science activities under investigation requires a departure from the "teacher front and centre" arrangement of more conventional classes. On the surface, it would appear that this would naturally lead to a reduction in teacher dominance of classroom activities. A study of the behaviour of the teacher relative to the pupils in a small group should

shed light on whether, in fact, a reduction in teacher dominance does occur.

Although a number of studies (e.g. Gump, 1967; Adams and Biddle, 1970; Hess and Takanishi, 1974; Stallings and Kaskowitz, 1974) have examined group structure in the classroom in terms of group size and function and in terms of the influence of grouping on outcomes, the question of the behaviour of individuals within a group has rarely been addressed. In the specific context of science laboratory groups, three such studies (Hurd and Rowe, 1966; Mayfield, 1976; Abraham, 1976) have been found. While these studies are not directly comparable, they do suggest that group structure is significantly associated with within-group behaviour and with outcomes. None of these studies, however, speak to the question of teacher role in the group, particularly as it relates to teacher control of the class activities.

Method

Videotape recordings of a single class session in each of thirteen classes (six second-grade, three fourth-grade, and four sixth-grade) formed the basic data for the descriptive phase of the study. In each classroom, two independently operated VTR units were used, each of which was focused on one randomly selected pair of pupils throughout the lesson. Recordings from ten of these classes, yielding usable data on nineteen pairs of pupils, were used in the study of teacher interventions.

Teacher and pupil behaviours were coded using a

modified version of the Bellack classroom observation system (Bellack, et al., 1966), developed as part of the larger study. The major modifications were as follows:

1. Both speaker and receiver of a communication were identified.

2. The coding unit was changed from the pedagogical move to the sentence to reduce ambiguities in defining the boundaries of the coding unit, to eliminate the need to code both lines and moves, and to permit the coding of separate substantive or instructional categories within a move.

3. Categories in the substantive-logical dimension were made consistent with the process nature of the science activities.

4. The instructional dimension was revised and expanded to more clearly reflect the emphasis on control required in the study.

5. Categories for physical action were developed.

Table I gives a brief summary of the major dimensions of the revised system. A coding manual, including operational definitions of the various categories is available from the second author.

Coding was carried out by a team of four coders, all of whom had been involved in the development of the system. It was thus possible for coders to attain proficiency in the use of the system while it was under development. The process also made it possible to approach the problem of reliability from a developmental perspective.

After attempting several coding procedures, a procedure was adopted whereby each transcript was coded by a single

TABLE I

SUMMARY OF DIMENSIONS OF CODING SYSTEM

DIMENSION	DESCRIPTION
1. SPEAKER-RECEIVER	NUMERICAL CODES USED FOR TEACHER AND FOR EACH PUPIL IN GROUPS BEING RECORDED.
2. LESSON PHASE	EACH LESSON DIVIDED INTO FIVE PHASES FROM PROBLEM SPECIFICATION TO CLEANUP. WITHIN EACH PHASE, DISCOURSE CODED AS ON TASK, INDIRECTLY ON TASK AND OFF TASK.
3. PEDAGOGICAL MOVE	STRUCTURING, SOLICITING, RESPONDING, REACTING AS IDENTIFIED BY BELLACK. MODIFICATIONS MADE IN DEFINITIONS TO REFLECT DIRECT EMPIRICAL CHARACTER OF SCIENCE LESSONS.
4. SUBSTANTIVE-LOGICAL	CATEGORIES CORRESPONDING TO PROCESSES FROM SCIENCE-A PROCESS APPROACH, IN ADDITION TO CATEGORIES FROM ORIGINAL BELLACK SYSTEM.

TABLE I CONTINUED
SUMMARY OF DIMENSIONS OF CODING SYSTEM

DIMENSION	DESCRIPTION
5. CONTROL	SENTENCES CODED AS STATEMENT, COMMAND, REQUEST, WITH MODIFIERS TO INDICATE MORE SPECIFIC CONTROL ACT.
6. TYPE OF REFERENCE	BELLACK'S INSTRUCTIONAL CATEGORIES MODIFIED TO INCLUDE OBSERVED PHENOMENA, APPARATUS REFERENCES, EXPECTED OUTCOMES AND OTHER UNIQUE ASPECTS OF SCIENCE LESSONS.
7. RATINGS	POSITIVE, QUALIFYING, REPEATING, NEGATIVE EVALUATIONS OF PREVIOUS BEHAVIOURS (CODED FOR REACT MOVES).
8. PHYSICAL ACTIONS	CATEGORIES FOR APPARATUS MANIPULATION, DATA RECORDING, AND OTHER MOVEMENT.

individual with his coding being reviewed by a second person. At this stage, coders were reasonably aware of each other's biases and could watch for instances of systematic error which contributed most to differences between coders (it was found, for example, that a single difference between coders in their interpretation of the definition of a category could lead to a large number of coding discrepancies when the work of the two coders was compared sentence by sentence). Reliability indices ranged from .50 to .99 depending on the dimension and on whether the measurement was made before or after the review.

Because of the exploratory nature of the study, the findings presented here are limited to those which provide an overview of teacher and pupil behaviour during teacher interventions. Nevertheless, these findings do seem to provide a unique perspective on the structure of the lessons, since they reveal the teacher in a situation of having to devote attention only to two pupils, and it gives pupils a unique opportunity to interact with the teacher free from the competing influence of a large number of other pupils. By comparing certain behaviours during interventions with those outside the interventions, it should be possible to shed particular light on the pervasiveness of teacher control (whether conventional teacher behaviours are transferred to the small group situation). Particular attention is given to the range of certain observed behaviours since this gives some indication of the extremes that might be expected under ordinary classroom conditions (the original purpose in carrying out this study was to help

identify teacher behaviours that might be used in defining treatments in a subsequent experimental study).

Some of the specific questions addressed in the following discussion are as follows: Do interventions occur on the basis of pupil demand or does the teacher appear to retain control of the allocation of her time? Do some pupils have greater access to teacher time than others? If so, is this a matter of pupil demand or of teacher choice? What are some of the reasons for the initiation of interventions? How do patterns of pedagogical moves during interventions compare to those in other settings? How long and how frequent are the interventions for a particular group? What changes in nature of discourse occur from beginning to end of an intervention. The findings which bear on these questions are interpreted in the light of the overall issue of teacher control as it relates to the larger study.

Initially, an intervention was defined as occurring whenever a sentence with teacher as speaker appeared in a series of sentences involving the two pupils under analysis, or if one of these pupils requested teacher attention and received a response. A manual search of the coded data was made in order to identify the beginning and end sentences of each intervention and to separate instances of intervention from other occasions in which the teacher might speak to one of the target pupils (such as during teacher-class interactions). In this manner, a total of 149 interventions were identified. A computer program was then developed to construct a file of interventions from the main data file. This intervention file was used as the basis for the various computation leading to the results reported here.

Results

Table II summarizes the findings with respect to the number of interventions per group and the length of interventions. These findings suggest that, in general, teachers spent a relatively short time with a group on each occasion, although some notable exceptions did occur to this trend. Some teacher attention was also given to all groups. This seems to suggest that the teacher maintains a fairly high degree of control over time allocation and that, with few exceptions, particular groups do not command an inordinate amount of teacher time (the major exception of the 63 sentence intervention occurred in a rather lengthy grade six lesson). The negative correlation between intervention length and intervention number (with intervention number adjusted for variations in lesson length) also supports this argument, although the correlation is not as large as might have been expected.

The following is a brief summary of findings related to the initiation of interventions and the sequence of events once the intervention commenced:

1. Teachers and pupils account for almost exactly an equal number of initiations (75 for pupils, 74 for teachers).

2. For short (1-3 sentences or one teaching cycle) teacher initiated interventions, requests outnumbered statements as initiating moves 39 to 25 (the absence of commands as initiators is notable). Declarative openings were characterized by statements about procedure, which pupils generally accepted without comment. Among the requests, progress reports (18), and requests for clarification (9) occurred most often, with pupils generally complying with the request.

3. For short student initiated interventions, the situation was reversed, with declarative openings occurring more than twice as often as requests. Giving progress reports and reporting observations were the most common declarative openings, while requests were either for clarification or for teacher procedural statements.

4. The pattern for initiation of longer interventions closely paralleled that for short interventions. As the discussion proceeded, pupil reporting of progress and observations, and pupil requesting and teacher giving clarifications remained predominant. However, a dramatic shift occurred near the end of these longer interventions. These almost invariably ended with the teacher making a statement about procedure.

The proportion of teacher and pupil sentences uttered during interventions compared to those during teacher-class interactions are shown in Table III. Considering the large difference in the teacher-pupil ratio in the two settings, these proportions seem remarkably stable. Nevertheless, it should be noted that the proportions are as notable for their inter-class variation as for the similarity of means. Also, the correlation of .47 between teacher talk during and outside interventions does not reach significance at the .05 level so it is not possible to demonstrate that proportion of talk is a particular characteristic of the teacher rather than of other variables in the setting. The somewhat smaller range for the interventions perhaps reflects the relative homogeniety of the intervention setting compared to the class setting.

TABLE II

SUMMARY OF FINDINGS FOR INTERVENTION LENGTH AND NUMBER

VARIABLE OR COMPARISON	RESULT
INTERVENTION LENGTH	RANGE 1-63 SENTENCES, MEAN 7.4 S.D.3.6. DISTRIBUTION HIGHLY SKEWED WITH SHARP DROP IN FREQUENCY WITH INCREASED LENGTH. ISOLATED INSTANCES ONLY OF INTERVENTIONS LONGER THAN 15 SENTENCES.
NUMBER OF INTERVENTIONS PER GROUP	RANGE 3-16, MEAN 7.9, S.D.3.9. DISTRIBUTION APPROXIMATELY RECTANGULAR.
GRADE LEVEL COMPARISONS	NO SIGNIFICANT DIFFERENCES BY ANOVA. INSTANCES OF VERY LONG INTERVENTIONS CONFINED TO SIXTH GRADE, LIKELY REFLECTING INCREASED LESSON LENGTH.
GROUP AND CLASS COMPARISONS	NO SIGNIFICANT DIFFERENCES BETWEEN GROUPS WITHIN A CLASS; SIGNIFICANT BETWEEN CLASS DIFFERENCES FOR GRADE 2 ONLY.

TABLE II CONTINUED
SUMMARY OF FINDINGS FOR INTERVENTION LENGTH AND NUMBER

VARIABLE OR COMPARISON	RESULT
CORRELATION OF LENGTH AND NUMBER OF INTERVENTIONS	$r = -.26$, $p < .05$
PACE OF DISCOURSE	DISCOURSE MORE RAPIDLY PACED DURING INTERVENTION THAN WHEN PUPILS WORKED WITHOUT TEACHER.

Further information on the stability of behaviours in intervention and non-intervention settings can be found in the comparison of pedagogical moves in the two settings which appear in Table IV. Again, in spite of the change of setting, the pattern of teacher moves appears quite stable. This is particularly true for soliciting, the primary teacher move. (The ranges for moves are also substantially narrower than for total talk). A comparison of teacher and pupil moves in the intervention setting reveals the pattern of teacher-solicit/pupil response that has become familiar in studies using the Bellack system. It is important to note, however, that the proportion of pupil solicits is somewhat higher and that for responses somewhat lower than those found in most studies. For example, in the original Bellack study, the proportion of pupil moves in the solicit category was only .13 while the proportion of responses was .69. Similarly, Lundgren (1972) found proportions of .10 and .61 for pupil solicits and responses respectively. What occurs in the science class setting is thus different in detail but not in general structure from what has been found in more conventional recitation classes, even though teacher behaviour across settings within the class is quite stable.

The proportions shown in Table IV for pupil moves in the non-intervention setting are not directly comparable to the remaining proportions because they include a large number of pupil-pupil interactions that occur in the absence of the teacher. Also, the large proportion of react moves reflects an artifact of coding whereby utterances about

TABLE III

PROPORTIONS OF TEACHER AND PUPIL TALK DURING INTERVENTIONS AND DURING TEACHER-CLASS INTERACTIONS

PROPORTION		INTERVENTIONS	TEACHER-CLASS INTERACTIONS
TEACHER TALK	MEAN	.64	.56
	RANGE	.47 - .87	.40 - .69
PUPIL TALK	MEAN	.36	.44
	RANGE	.13 - .53	.28 - .60

TABLE IV

MEAN PROPORTIONS OF TEACHER AND PUPIL DISCOURSE FOR EACH PEDAGOGICAL MOVE

	TEACHER		PUPIL	
MOVE	NON-INTERVENTION	INTERVENTION	NON-INTERVENTION	INTERVENTION
STR	.23	.15	.13	.05
SOL	.53	.56	.31	.32
RES	.03	.10	.14	.41
REA	.18	.19	.33	.03

direct observations were coded as reacts. Nevertheless, they do indicate that pupil behaviour changes markedly from a setting with the teacher present to one in which the teacher is not involved. Teacher behaviours, on the other hand show no comparable change from the many-pupil to the two-pupil situation.

Proportions of sentence types shown in Table V again confirm the relative stability of the pattern of teacher utterances, and the contrast with that for pupils. Since requests and commands were both associated with the solicit move, the Table V data serves to refine the argument in that it is clear that most teacher solicits are in the form of requests. The earlier data on initiations suggests that these requests were commonly for progress reports or for clarifications. The proportion of pupil commands seems incongruous with teacher and pupil roles. However, in the non-intervention setting, most pupil commands were directed at the other pupil and tended to refer to apparatus manipulations or to observations. It seems reasonable to argue that this also accounts for the commands during the interventions.

Tables VI and VII give the proportions of sentences in each of the categories in the type of reference and rating dimension. The relative stability of teacher behaviour is perhaps the most salient feature of these data. In the case of references, teacher and pupil proportions follow similar patterns. This might be expected, since the flow of discourse tends to be such that contiguous sentences are likely to be related to each other in content as reflected in these categories.

TABLE V

PROPORTIONS OF STATEMENTS, REQUESTS, AND COMMANDS FOR TEACHERS AND PUPILS

	Teacher		Pupil	
Category	Non-Intervention	Intervention	Non-Intervention	Intervention
Statement	.28	.28	.29	.40
Request	.38	.35	.08	.13
Command	.15	.20	.21	.16
Not Coded	.19	.17	.41	.31

In contrast, teacher and pupil use of ratings differs sharply. Pupils show much greater use of negative ratings but rarely qualify or repeat. The latter seems to be a clear instance of different pupil and teacher roles since the repeating or modifying a pupil response seems to be a common teacher device. It is interesting to note that pupils become much more positive and much less negative during interventions. Again, this appears to reflect the presence of the teacher. In the pupil-pupil setting it was quite common for a pupil to admonish his partner (using statements of the type "no, don't do that!"), especially with reference to apparatus manipulation. In the intervention setting it would be highly unlikely that the pupil would react to the teacher in this manner.

Discussion

Although the fact that pupils initiate about half the interventions seems to suggest a relatively high degree of pupil control of teacher time, this result must be interpreted in the light of the fact that each class consisted of some fifteen groups and that experience indicates that simultaneous requests for teacher attention by several groups is common in such classes. Under these conditions the teacher must often ignore some requests while attending to others. While no direct evidence is available of how the teacher selects particular groups for attention, it does seem surprising that the teacher can initiate half the interventions under the conditions described. This suggests that the teacher does retain substantial control over the allocation

TABLE VI

PROPORTIONS OF TYPE OF REFERENCE CATEGORIES FOR TEACHERS AND PUPILS

	Teacher		Pupil	
Category	Non-Intervention	Intervention	Non-Intervention	Intervention
Procedure	.05	.08	.02	.06
Actions (Physical, cognitive, vocal)	.19	.18	.15	.09
Apparatus	.39	.50	.40	.38
Individual Results	.11	.09	.05	.13
Class Results	.10	---	---	---
Expected Outcomes	.03	.03	.01	.03
Phenomena	.02	.03	.12	.07
TOTAL*	.89	.91	.75	.76

*Remaining proportion divided among other categories or not coded in this dimension.

TABLE VII

PROPORTIONS OF RATINGS FOR TEACHERS AND PUPILS

	TEACHER		PUPIL	
CATEGORY	NON-INTERVENTION	INTERVENTION	NON-INTERVENTION	INTERVENTION
POSITIVE	.32	.38	.30	.50
QUALIFYING	.15	.13	.04	.04
REPEATING	.27	.24	.05	.04
NEGATIVE	.17	.25	.61	.42

*REQUEST FOR RATING IN CATEGORY POSITIVE/NEGATIVE IS NOT SHOWN IN THE TABLE.

of her time among groups. A similar conclusion follows from the fact that more of the observed groups totally lacked teacher attention.

Further evidence for this conclusion lies in the tendency for teachers to break off longer interventions, specifically with directions about procedure. This presumably serves to ensure that the group can continue the activity in the teacher's absence and permits the teacher to give attention to other groups.

The overall consistency of teacher moves in the intervention and non-intervention settings, and the general conformity of the distributions of teacher moves to those found in studies of more conventional classes, again suggests that teacher role is quite well defined, and stable across settings. The same general conclusion is supported by the consistency of teacher behaviours in other dimensions of the coding system.

The fact that pupil behaviours, particularly pedagogical moves, change substantially from the non-intervention to the intervention setting, even though the surface change is simply from a two-person group to a three-person group, clearly indicates that the addition of the teacher leads to a substantial change in person roles in the group. Interventions more closely resemble teacher-class interactions than they do pupil-pupil interactions.

In terms of the behaviour setting construct, the results suggest that the setting may be better defined by teacher and pupil roles than by surface features such as

group size. Similarly, it would appear that a shift from strong to weak framing, in the Bernstein sense, must involve more than a change in grouping structure or a move to place pupils in an active manipulative role rather than in the role of attending to the teacher as found in conventional classes.

These findings have interesting implications for science curriculum, particularly for those programs which have attempted to implement the goal of promoting pupil inquiry (in either its scientific or its pedagogical sense) by requiring that activities be conducted in a laboratory setting (a feature which most major elementary science programs seem to have in common). If teacher role is as stable as it appears to be from the results of this study, and if pupil behaviours change to conform to particular role expectations, then the change from class to group format may represent a surface change only and does not necessarily represent a move towards greater pupil independence. This is not to imply that the promotion of pupil independence is an impossible goal. Nor does it deal with the question of whether this goal is desirable. It simply suggests that changing the surface structure of the class may not be sufficient to ensure a change towards greater pupil independence.

NOTES

1. Preliminary findings from the experimental study are reported elsewhere at this meeting. See Crocker et al, An Experimental Study of Teacher Control in Sixth Grade Science Classes.

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